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Proposal Title: **Use of a coupled, global cloud-scale and land surface modeling system to study the impact of land surface processes on energy and water cycles**

ABSTRACT

Recent GEWEX Cloud System Study (GCSS) model comparison projects have indicated that cloud-resolving models (CRMs) agree with observations better than traditional single-column models in simulating various types of clouds and cloud systems from different geographic locations. Current and future NASA satellite programs can provide cloud, precipitation, and aerosol data at very fine temporal and spatial scales. Such programs require a coupled, general circulation model (GCM) and cloud-scale model (termed a super-parameterization or multi-scale modeling framework, MMF) in order to use these satellite data to improve our understanding of the physical processes that are responsible for variations in global and regional climate and hydrological systems.

We propose to use the coupled Goddard finite volume general circulation model (fvGCM) and the Goddard Cumulus Ensemble (GCE) model, a CRM, to study the impact of surface processes on local, regional and global water and energy cycles. The coupled modeling system will also couple with the Goddard Land Information System (LIS), which includes several land surface models and high-resolution land datasets. The use of a GCM will enable global coverage, and the use of a CRM will allow for better and more sophisticated physical parameterization. The use of the coupled fvGCM, CRM and LIS will allow us to (1) assess the impact of land surface heterogeneities (e.g., topography, soils, vegetation and land cover) on the local, regional and global hydrological cycle, (2) examine the impact of the spatial and temporal scales of land surface physics on clouds and precipitation, and (3) quantify the interactive soil-vegetation-precipitation processes, surface heterogeneity and their influence on preferential convective initiation and precipitation processes.

In addition, a series of sensitivity tests will be performed to quantify the impact of various large-scale conditions [i.e., surface characteristics (hot and dry or cold and moist) and middle tropospheric moisture (dry/moist)] on the frequency of convective development and its organization, structure and rainfall intensity. These experiments will help to address one of the main questions in long-term climate change--will deep convection intensify in a warmer climate?

Tropical Rainfall Measuring Mission (TRMM) three-hourly rainfall data, TRMM Precipitation Radar (PR) products and data from major field campaigns [i.e., Coordinated Enhanced Observing Period (CEOP), Department of Energy (DOE)/Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) Cloud and Radiation Testbed (CART), and International H2O project (IHOP_2002)] will be used for model validation on various space and time scales.

The proposed research meets the requirements and addresses the scientific problems as stated in NN-H-04-Z-YS-005 N and particularly focuses on the NASA Energy and Water Study (NEWS). Here we will utilize NASA observations to develop and improve process-level model components to better define the clouds, precipitation, and dynamics that couple the water and energy cycles. The proposed use of the coupled fvGCM-GCE modeling system (super-parameterization) also meets one of the four major NEWS strategic elements or challenges.

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